AD-A118 869 MASSACHUSETTS INST OF TECH LEXINGTON LINCOLN LAB F/G 9/5
ADVANCED ELECTRONIC TECHNOLOGY.(U)
FEB 82 A J MCLAUGHLIN, A L MCWHORTER F19628-80-C-0002
ESD-TR-82-009 NL

UNCLASSIFIED

END
DATE FILMED
10-82
DTIC

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

ADVANCED ELECTRONIC TECHNOLOGY

QUARTERLY TECHNICAL SUMMARY REPORT
TO THE
AIR FORCE SYSTEMS COMMAND

1 NOVEMBER 1981 — 31 JANUARY 1982

ISSUED 21 JUNE 1982

LEXINGTON MASSACHUSETTS

INTRODUCTION

This Quarterly Technical Summary covers the period 1 November 1981 through 31 January 1982. It consolidates the reports of Division 2 (Data Systems) and Division 8 (Solid State) on the Advanced Electronic Technology Program.

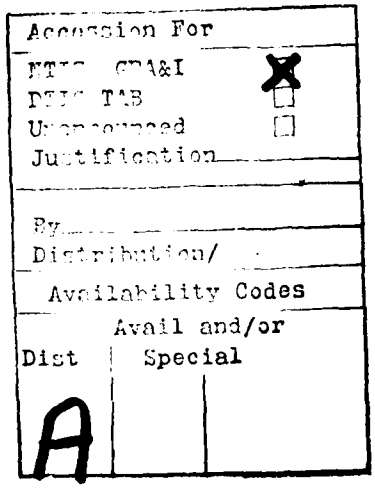


TABLE OF CONTENTS

DATA SYSTEMS
DIVISION 2

INTRODUCTION

This section of the report reviews progress during the period 1 November 1981 through 31 January 1982 on Data Systems. Separate reports describing other work of Division 2 are issued for the following programs:

Seismic Discrimination	ARPA/DSO
Distributed Sensor Networks	ARPA/IPTO
Defense Switched Network Technology	OSD-DCA
Digital Voice Processing	AF/ESD
Digital Voice Interoperability Program	AF/ESD
Packet Speech Systems Technology	ARPA/IPTO
Radar Signal Processing Technology	ARMY/BMDATC
Restructurable VLSI	ARPA/IPTO
Multi-Dimensional Signal Processing	AF/RADC

A.J. McLaughlin
Head, Division 2

T. Bially
Associate Head

DIGITAL INTEGRATED CIRCUITS
GROUP 23

I. INTRODUCTION

The Phase 1 Integrator cell has been fabricated and tested and the design verified by successful functional operation of a number of chips. Hardware and software for automatic positioning and linking on the new X-Y laser table have been demonstrated. A lateral link using a single level of metal has been developed with resistances in the 1-Ω range with good uniformity and the promise of both higher density and lower capacitance than two-level links.

II. RVLSI CIRCUITS

A. Redesign of Phase 0 Integrator

As a result of experience obtained in diagnosing the Phase 0 Integrator, modifications to reticles above first metal have been made. These incorporate: (1) amorphous silicon in the insulating layer between first- and second-level metal at crossovers to reduce incidence of shorts; (2) large links in second-level metal power jumpers in place of vias so that the power supply buses are segmented and then laser linked to provide defect avoidance; (3) detailed redesign of the link region to eliminate a deep trough from which it was difficult to remove second-level metal.

An additional redesign is in process which incorporates probe pads on all wafer-scale interconnect. At wafer probe, the capacitance will be measured at each of these pads and at each circuit pad. Below-normal capacitance will indicate a line with an open; above-normal capacitance will indicate a short to another line. These data will provide, at wafer probe, a list of usable tracks as well as cells for use by the automated assignment and linker program and reduce the number of time-consuming tests required on the laser table.

B. RVLSI Spread-Spectrum Integrator

The first run of the spread-spectrum integrator test-chip wafers has been processed. The integrator cell functions properly at wafer probe test at a 0.5-MHz clock rate. Good chips will be packaged and tests made at higher speed.

C. FFT for Radar Applications

Wafer processing of the FFT cells is presently at first-level metal. A relatively minor redesign, placing a probe pad on each wafer-length track, is required before the full wafer version can be started.

The software tools which will be used to perform automatic linking for the FFT wafer have been completed and have been used successfully to route more than 98 percent of the nets for many random distributions of good cells. A system which incorporates an AED 512 color graphics terminal for visual feedback has been developed in which the uncompleted nets can be routed by hand. Improvements in the linking algorithm should continue to raise the success rate for automatic linking.

D. Tester

A Tektronix S3260 test system has been leased and installed, but a connection to our prober has not been made yet. This equipment will enable us to perform testing on wafers and packaged devices up to 20-MHz clock rates. The system will test devices with up to 64 I/O signal pins and, at lower clock rates, with up to 64 input and 64 output pins.

III. RESTRUCTURABLE VLSI TECHNOLOGY

A. Laser Formed Connections

Much of the laser connection work in the past quarter has concentrated on linking Phase 0 Integrator wafers. These first wafers had several processing problems which prevented their being used as full integrators. Nevertheless, on one wafer the signal and power terminals of two 4-bit counter cells were laser linked through wafer-length buses to external wafer pads. These parallel counters were restructured into a single 8-bit counter several times using the laser to make and break connections. The 2-in. wafer was mounted in a Lincoln Laboratory-built 80-pin test jig which demonstrates a technique which might be used to package these large devices.

A second wafer has just undergone complete testing of its bus lines using the laser-linking scheme. In this case each bus line was checked for opens, shorts to its neighbors, and first- to second-level metal shorts using test links. These experiments established the reliability of the barrier protected links. Over 1300 links were made with no apparent failures. Excluding gross processing defects, only 5 unformed links appeared to be shorted on a wafer which contained approximately 50,000 links.

B. Lateral Links

Low-resistance laser linking has been demonstrated in a simple, yet practical lateral structure using one level of metal. The structure is composed of 8-μm-wide Al or AlSiCu metal lines with gaps cut in them on an unpatterned, layered structure of 0.01-μm thermal oxide on top of 0.5-μm undoped polysilicon over 1-μm field oxide, on a Si substrate. The 0.01-μm oxide prevents metal-Si interdiffusion which would otherwise short the unformed links during conventional post-metallization sintering. Over 250 devices have been laser linked across metal gap widths of 1.7, 2.0, and 2.4 μm, and at laser powers ranging from 1.0 to 1.4 W. The typical link resistance is 0.8 Ω (for all gap widths) with a worst-case value of 3.2 Ω. The links carry in excess of 70 mA with no change in resistance. Good linking is obtained even when the laser beam is off target by as much as 2.2 μm. Unprogrammed links with a 2.4-μm metal gap have off-resistances in excess of 10^9 Ω and breakdown voltages of about 80 V.

C. Laser System

A new laser table has been installed which positions the wafer within ±2 μm across a 2-in. wafer. There is a slight nonorthogonality of motion which is being corrected in the table-positioning program. This computer program directs the table to the position of each link, given its address in terms of cell and track names. An autofocus program has also been implemented in the system, thus completing the first fully operational version of a laser programming system.

IV. SEMICONDUCTOR PROCESSING

A. Lithography

Use of the DSW system to place four different images from a single reticle on a wafer for the RVLSI work has revealed that the match between levels for certain image positions may vary by 2 μm. This is thought to be due to a combination of pattern-generator error, DSW stepping error, and resist dimensional variation due to exposure fluctuation, all recurring through two or three reticle levels. Occasional improper individual exposures seem to have been eliminated by replacement of the shutter solenoid in the DSW system.

B. Dry Etching

The reactive ion etching system is now functional and produces vertical sidewalls with reasonably high etch rates. A process for plasma etching of polysilicon with either Freon 115 or Freon 13 is undergoing final development. Etch rates of 1500 Å/min. in polysilicon and 100 Å/min. in oxide have been observed, and the sidewall anisotropy can be controlled with DC bias applied to the RF electrode. In plasma etching of aluminum, it has been found that additions of pure chlorine to the BCl_3 will more than double etch rate with no observable side effects. We have etched 4-μm-thick aluminum with this system with very good results.

C. Second-Level Metal CMOS Processing

The intermetal contact resistance problems encountered when using AlSiCu for both first- and second-level metals have been studied. It is theorized that the Si in the usual AlSiCu-Al two-level metal system quickly diffuses into the Al from the supersaturated AlSiCu at sinter temperatures. This diffusion is thought to provide "mixing" of the Al at interface of the first- and second-level metal and thus low metal-to-metal contact resistance is achieved. This is not possible when both levels of metal are supersaturated with Si, and it was found that an oxide removal process using chromium trioxide - phosphoric acid before deposition of second-level metal was the best of several treatments in producing low via resistance.

Bubbling of second-level metal in large unpatterned metal areas following sinter was traced to insufficient curing of the polyimide which outgassed and caused the metal to blister where the vapor could not escape. Use of a high-temperature (450°C) sinter prior to second-level metallization has corrected this. Polyimide was found to be only 5000 Å thick on some Phase 0 arrays, and where it went over the edge of first-level metal it was perhaps only half that thickness. This thickness will be increased on future runs. Mask changes were made so that amorphous silicon is left under the polyimide at first- and second-level metal crossings so as to reduce the possibility of shorting.

D. CMOS Processing

The fabrication of correlator cells using the CMOS gate array for another Lincoln project has been successfully completed, with chip yield of 70 percent. Several of these are being packaged for further evaluation.

V. DEVICE THEORY

A. Nitrided Oxide

The kinetic model described in the preceding Quarterly Technical Summary* provided a good fit to growth vs time, but could not be reconciled with the experimentally observed dependence of interface growth on temperature or initial oxide thickness. A much-less phenomenologically based model is being prepared which indicates chemical changes in the film that are believed to be associated with the observed electrical changes. We have developed improved techniques for reduction of Auger data which appear capable of providing the nitrogen composition on an atom-by-atom basis through the film thickness. We already have seen that the film is much more heavily nitrided than heretofore considered. A consequence of this heavy

*Quarterly Technical Summary, Advanced Electronic Technology, Lincoln Laboratory, M.I.T. (15 November 1981), DTIC AD-A114319.

degree of nitriding is that water liberated by the nitridation provides competition with the ammonia from the atmosphere to oxidize rather than nitride the interface.

B. Modeling of Photodepopulation of MNOS Diodes

A model of the photodepopulation of MNOS diodes has been developed for use in studying the experimental photodepopulation data obtained previously. Currently, the program for the model is being debugged.

COMPUTER SYSTEMS

GROUP 28

All the hardware, including a tape drive and a 160-Mbyte hard disk, has been installed on the DEC PDP-11/44 computer and integrated with the UNIX Operating System. Testing of the IMP-11B interface is proceeding as the port expander for the ARPANET IMP becomes operational. On the software side, the TCP/IP protocol will be implemented by acquiring the UNET package from 3COM Corporation. Work is in progress to develop the software interface between UNET and the Lincoln Internal Data Link (LIDL) which will connect to the Amdahl V/8 central computer. Since the present V/8 software support for the NCP protocol involves a completely separate hardware connection to the IMP, development of the TCP/IP protocol support will not impact the present Network access. This dual capability will be helpful during the transition of the ARPANET from NCP to TCP/IP.

To further support this new ARPANET interface, a "C" language compiler is being installed on the Amdahl V/8. One of the first tasks it will perform is that of producing a functionally similar version of the UNET/LIDL connecting software, for the LIDL/Amdahl V/8 link. This is the final bridge between an interactive user of the central facility, through the Lincoln Internal Data Link and PDP-11/44, to the ARPANET.

The graphics software packages DISSPLA and TELL-A-GRAF have been obtained from Integrated Software Systems Corporation and are being installed on both the interactive and batch operating systems. These packages will gradually replace most of the Laboratory's current graphics software which is based on an old system which cannot readily support modern features such as color, high-resolution plots, and multiple-character fonts. While the installation of the software has been relatively easy, a considerable amount of work remains to be done on developing Lincoln operating procedures and educating general users.

SOLID STATE
DIVISION 8

INTRODUCTION

This section of the report summarizes progress during the period 1 November 1981 through 31 January 1982. The Solid State Research Report for the same period describes the work of Division 8 in more detail. Funding is primarily provided by the Air Force, with additional support provided by the Army, DARPA, Navy, NASA, and DOE.

A.L. McWhorter
Head, Division 8

I. Melngailis
Associate Head

DIVISION 8 REPORTS
ON ADVANCED ELECTRONIC TECHNOLOGY

15 November 1981 through 15 February 1982

PUBLISHED REPORTS

Journal Articles

JA No.			
5172	A Theoretical Note on the Structural Features Observed in Pulsed Energy-Beam Crystallization	H.J. Zeiger M.J. Larsen B.J. Palm	Appl. Phys. Commun. 1, 61 (1981), DTIC AD-A110706
5243	Ultrathin, High-Efficiency Solar Cells Made from GaAs Films Prepared by the CLEFT Process	C.O. Bozler R.W. McClelland J.C.C. Fan	IEEE Electron Device Lett. EDL-2, 203 (1981)
5244	Optical Reflectance Technique for Observations of Submonolayer Adsorbed Films	V. Daneu R.M. Osgood, Jr. D.J. Ehrlich	Opt. Lett. 6, 563 (1981), DTIC AD-A113232
5246	Slider LPE of $Hg_{1-x}Cd_xTe$ Using Mercury Pressure Controlled Growth Solutions	T.C. Harman	J. Electron. Mater. 10, 1069 (1981), DTIC AD-A107976/3
5249	Laser Microreaction for Deposition of Doped Silicon Films	D.J. Ehrlich R.M. Osgood, Jr. T.F. Deutsch	Appl. Phys. Lett. 39, 957 (1981), DTIC AD-A113231
5263	Sub-Doppler Submillimeter Spectroscopy Using Molecular Beams	W.A.M. Blumberg D.D. Peck H.R. Fetterman	Appl. Phys. Lett. 39, 857 (1981), DTIC AD-A113233
5276	n-Channel Deep-Depletion Metal-Oxide-Semiconductor Field-Effect Transistors Fabricated in Zone-Melting-Recrystallized Polycrystalline Si Films on SiO_2	B-Y. Tsaur M.W. Geis J.C.C. Fan D.J. Silversmith R.W. Mountain	Appl. Phys. Lett. 39, 909 (1981), DTIC AD-A113234
5291	Electrical Properties of Laser Chemically Doped Silicon	T.F. Deutsch D.J. Ehrlich D.D. Rathman D.J. Silversmith R.M. Osgood, Jr.	Appl. Phys. Lett. 39, 825 (1981), DTIC AD-A110715
5293	Infrared Laser Developments	A. Mooradian P.F. Moulton	Laser Focus 18, 52 (1982)

Meeting Speeches

MS No.			
5618	Lateral Growth of Single-Crystal InP Over Dielectric Films by Orientation-Dependent VPE	P. Vohl C.O. Bozler R.W. McClelland A. Chu A.J. Strauss	J. Cryst. Growth 56, 410 (1982), DTIC AD-A113266
5653	Linewidth Characteristics of (GaAl)As Semiconductor Diode Lasers	A. Mooradian D. Welford M.W. Fleming	In Laser Spectroscopy V, edited by A.R.W. McKellar, T. Oka, and B.P. Stoicheff (Springer-Verlag, New York, 1981), p. 67
5720	Laser-Photochemical Techniques for VLSI Processing	D.J. Silversmith D.J. Ehrlich R.M. Osgood T.F. Deutsch	1981 Symposium on VLSI Technology, Maui, Hawaii, 9-11 September 1981, Digest of Technical Papers, pp. 70-71
5745	New Techniques and Applications for High Resolution Tunable Submillimeter Spectroscopy	H.R. Fetterman W.A.M. Blumberg	In Laser Spectroscopy V, edited by A.R.W. McKellar, T. Oka, and B.P. Stoicheff (Springer-Verlag, New York, 1981), p. 76
5797	Vertical Single-Gate CMOS Inverters on Laser-Processed Multilayer Substrates	G.T. Goeloe E.W. Maby* D.J. Silversmith R.W. Mountain D.A. Antoniadis*	Proc. IEEE Intl. Electron Devices Mtg., Washington, DC, 7-9 December 1981, pp. 554-556
5803	Stress-Enhanced Mobility in MOSFETs Fabricated in Zone-Melting-Recrystallized Poly-Si Films	B-Y. Tsaur J.C.C. Fan M.W. Geis D.J. Silversmith R.W. Mountain	Proc. IEEE Intl. Electron Devices Mtg., Washington, DC, 7-9 December 1981, pp. 232-235

* * * * *

UNPUBLISHED REPORTS

Journal Articles

JA No.			
5250	A Calculation of the Capacitance-Voltage Characteristics of p^+-InP/n-InP/n-InGaAsP Photodiodes	J.P. Donnelly	Accepted by Solid-State Electron.
5277	Efficient Raman Frequency Conversion in Liquid Nitrogen	S.R.J. Brueck H. Kildal	Accepted by IEEE J. Quantum Electron.

*Author not at Lincoln Laboratory.

JA No.			
5282	Stress-Enhanced Carrier Mobility in Zone-Melting-Recrystallized Polycrystalline Si Films on SiO_2-Coated Substrates	B-Y. Tsaur J.C.C. Fan M.W. Geis	Accepted by Appl. Phys. Lett.
5283	Localized Laser Etching of Compound Semiconductors in Aqueous Solution	R.M. Osgood, Jr. A. Sanchez-Rubio D.J. Ehrlich V. Daneu	Accepted by Appl. Phys. Lett.
5305	Amorphous-Crystalline Boundary Dynamics in Laser Crystallization	H.J. Zeiger J.C.C. Fan B.J. Palm R.L. Chapman R.P. Gale	Accepted by Phys. Rev. B
5308	Applications of Guided-Wave Interferometers	F.J. Leonberger	Accepted by Laser Focus
5312	4-Bit 828-Megasample/sec Electrooptic Guided-Wave Analog-to-Digital Converter	F.J. Leonberger C.E. Woodward R.A. Becker	Accepted by Appl. Phys. Lett.
5318	A Novel Technique for GaInAsP/InP Buried Heterostructure Laser Fabrication	Z.L. Liau J.N. Walpole	Accepted by Appl. Phys. Lett.
5320	Observation of Linewidth Broadening in (GaAl)As Diode Lasers Due to Electron Number Fluctuations	D. Welford A. Mooradian	Accepted by Appl. Phys. Lett.
5326	Efficient GaAs Solar Cells Formed by UV Laser Chemical Doping	T.F. Deutsch J.C.C. Fan D.J. Ehrlich G.W. Turner R.L. Chapman R.P. Gale	Accepted by Appl. Phys. Lett.
MS-5748	Oxide Barriers to Formation of Refractory Silicides	D.J. Silversmith D.D. Rathman R.W. Mountain	Accepted by Thin Solid Films
MS-5765	Ion Beam Assisted Etching for GaAs Device Applications	G.A. Lincoln M.W. Geis L.J. Mahoney B.A. Vojak K.B. Nichols W.J. Piacentini N. Efremow W.T. Lindley	Accepted by J. Vac. Sci. Technol.
MS-5871	Picosecond InP Optoelectronic Switches	A.G. Foyt F.J. Leonberger R.C. Williamson	Accepted by Appl. Phys. Lett.

Meeting Speeches*

MS No.			
5607C	Pulsed Laser Processing of Semiconductors	T.F. Deutsch D.J. Ehrlich	12th Winter Colloquium on Quantum Electronics, Snowbird, Utah, 13-15 January 1982
5609B	Advances in Divalent Transition-Metal Lasers	P.F. Moulton	Lasers '81, New Orleans, Louisiana, 14-18 December 1981
5806	Some Surprising Results in Studies of Transition-Metal-Doped Crystals	P.F. Moulton	
5717D	Preparation of High-Quality Silicon Films on Insulators by Zone-Melting Recrystallization	J.C.C. Fan	Seminar, University of California, Berkeley, 19 November 1981
5748	Oxide Barriers to Formation of Refractory Silicides	D.J. Silversmith D.D. Rathman R.W. Mountain	Materials Research Society Conf., Boston, 16-19 November 1981
5760	Transient Heating with Graphite Heaters for Semiconductor Processing	J.C.C. Fan B-Y. Tsaur M.W. Geis	
5763	Preparation of Oriented GaAs Bicrystal Layers by Vapor-Phase Epitaxy Using Lateral Overgrowth	J.P. Salerno R.W. McClelland P. Vohl J.C.C. Fan W. Macropoulos C.O. Bozler A.F. Witt†	
5766	Effects of Interface Structure on the Electrical Characteristics of PtSi-Si Schottky Barrier Contacts	B-Y. Tsaur D.J. Silversmith R.W. Mountain C.H. Anderson, Jr.	
5767	Silicon-on-Insulator MOSFETs on Zone-Melting-Recrystallized Poly-Si Films on SiO_2	B-Y. Tsaur M.W. Geis J.C.C. Fan D.J. Silversmith R.W. Mountain	

*Titles of Meeting Speeches are listed for information only. No copies are available for distribution.

†Author not at Lincoln Laboratory.

MS No.			
5803A	Effect of Thermal Stress on the Carrier Mobility in Zone-Melting-Recrystallized Films on SiO_2-Coated Substrates	B-Y. Tsaur J.C.C. Fan M.W. Geis D.J. Silversmith R.W. Mountain	Materials Research Society Conf., Boston, 16-19 November 1981
5868	Crystallographic Characteristics of Si Films Recrystallized by Zone Melting	M.W. Geis H.I. Smith* B-Y. Tsaur J.C.C. Fan	
5765	Ion Beam Assisted Etching for GaAs Device Applications	G.A. Lincoln M.W. Geis L.J. Mahoney B.A. Vojak K.B. Nichols W.J. Piacentini N. Efremow W.T. Lindley	28th National AVS Symposium, Anaheim, California, 3-6 November 1981
5768	Applications of Scanning Electron Beam Lithography	T.M. Lyszczarz	Electron Beam Lithography for Microstructures Device Manufacture Mtg., Carmel, California, 1-3 November 1981
5826	Single-Mode GaInAsP Optical Waveguides	N.L. DeMeo F.J. Leonberger S.H. Groves	Sixth Topical Meeting on Integrated and Guided-Wave Optics, Pacific Grove, California, 6-8 January 1982
5835	Design Rules for Low-Loss Coherently-Coupled $LiNbO_3$ Waveguide Bends	L.M. Johnson F.J. Leonberger	
5840	GaInAsP/InP Double Heterostructure Laser with Monolithically Integrated Passive Waveguide	Z.L. Liau J.N. Walpole	
5845	4-Bit 275-MS/s Electrooptic A/D Converter	F.J. Leonberger C.E. Woodward R.A. Becker	
5846	External Cavity Controlled Operation of a Semiconductor Diode Gain Element in Series with an Optical Fiber	R.H. Rediker R.P. Schloss A. Mooradian D. Welford	
5842	Considerations for an Integrated Optical Spectrum Analyzer	P.V. Wright	IEEE Sonics and Ultrasonics Chapter Mtg., Sudbury, Massachusetts, 18 November 1981

*Author not at Lincoln Laboratory.

MS No.			
5854	Guided-Wave Electrooptic Modulators	F.J. Leonberger	Conf. on Fiberoptic Rotation Sensors, M.I.T., 10 November 1981
5862	Receiver Technology for the Millimeter and Submillimeter Wave Regions	B.J. Clifton	SPIE Mtg. on Integrated Optics and Millimeter and Microwave Integrated Circuits, Huntsville, Alabama, 16-19 November 1981
5887	Three-Terminal Device Used for Optical Heterodyning at Submillimeter IFs	H.R. Fetterman D.D. Peck A. Chu P.E. Tannenwald	1981 IEEE Intl. Conf. on Infrared and Millimeter Waves, Miami Beach, 7-12 December 1981

SOLID STATE
DIVISION 8

I. SOLID STATE DEVICE RESEARCH

The response speed of InP optoelectronic switches has been enhanced by using proton bombardment. Response times following bombardment of less than 100 ps have been deduced from photoconductivity measurements.

Individual bit channels of a 4-bit guided-wave electrooptic analog-to-digital converter have been operated at 828 MS/s. The conversion of an analog signal with the highest reported frequency of 413 MHz was demonstrated by means of a beat-frequency test.

A mass-transport phenomenon has been utilized to achieve GaInAsP/InP buried heterostructure (BH) lasers. The novel technique is considerably simpler and more easily controlled than previously reported ones, and has resulted in BH lasers with threshold currents as low as 9.0 mA.

II. QUANTUM ELECTRONICS

An average output power of 7.3 W at a 50-Hz pulse rate has been obtained from a Co:MgF_2 laser, and 20 mJ has been generated in a 200-ns-wide output pulse in Q-switched operation. Scaling relations to extend Q-switched operation to higher energies have been calculated.

As part of an effort to understand the basic mechanisms of the $MgF_2:V^{2+}$ laser, a theoretical fit for the $^4A_2 \rightarrow {}^4T_2$ zero-phonon absorption spectrum in σ and π polarization has been obtained. The fit indicates the presence of a strong Jahn-Teller interaction for the $^4T_2$ level.

Raman spectra of ultrathin Si films are being investigated as a probe of grain sizes in beam-recrystallized semiconductor materials. A strong broadening, as well as a low-frequency tail in the Si phonon Raman spectrum, is observed as the film thickness is decreased to ~30 Å.

Photolysis of H_2S with an ArF excimer laser has been used to form p-n junctions in GaAs by S-doping. Solar cells having AM1 efficiencies of 10.8 percent have been fabricated from these junctions.

Laser photochemical etching and deposition have been used to fabricate high-aspect-ratio, through-wafer via conductors. This technique for via-conductor fabrication should have application in the assembly of large-area focal-plane detectors.

Heterodyning in the visible has been carried out in GaAs FETs with IFs up to 300 GHz. This high-frequency response was independently verified in mixing experiments in the millimeter and submillimeter regimes. For IFs up to 40 GHz, the LO was injected directly into the gate, and the mixer operated as a three-terminal device.

III. MATERIALS RESEARCH

Measurements on thin-film resistors and n-channel MOSFETs fabricated in zone-melting-recrystallized Si films on SiO_2-coated Si substrates have shown that the sub-grain boundaries in these films have very little effect on electron transport. Minority-carrier-generation lifetimes in the microsecond range have been measured in such films and in epitaxial Si layers grown by chemical vapor deposition on these films. These results indicate that Si-on-insulator structures prepared by zone-melting recrystallization and subsequent epitaxial growth are potentially useful for integrated circuit and bipolar device applications.

To study the relationship between the structure and electrical properties of semiconductor grain boundaries, a novel technique has been developed for preparing bicrystals with specified grain boundary structure by means of vapor-phase epitaxy. A series of GaAs bicrystals has been grown with (110) tilt boundaries differing only in the magnitude of the [110] rotation angle. Initial electrical measurements indicate that the height of the potential barrier associated with these boundaries varies systematically with the rotation angle.

IV. MICROELECTRONICS

By using a top-down, self-aligning process, a joint-gate, vertically stacked CMOS inverter has been fabricated in a multilayer substrate. The nMOS transistor was formed in a layer of laser-recrystallized CVD silicon,

and the pMOS transistor in the underlying single-crystal silicon substrate. The low-frequency gain of the inverter was -12.5, and the rise and fall times were 2 μs.

Oxygen reactive-ion etching has been used to form a reusable, polyimide membrane mask for the proton exposure of resists. Lines as small as 600 Å have been replicated in PMMA using membranes 1 to 2 μm thick, a beam energy chosen so that the protons are stopped in the thick areas of the masks, and a dose of 2×10^{13} H^+ cm^{-2}.

A high-speed, CCD-based, two-dimensional correlation system has been built which correlates a 256 x 256-element signal with a 32 x 32-element reference in approximately 1 s; this corresponds to a computation rate of more than 100 million operations per second. The correlation is performed by two CCDs: a programmable transversal filter which performs a series of one-dimensional correlations, and an accumulating memory which sums these operations to form the two-dimensional correlation.

V. ANALOG DEVICE TECHNOLOGY

The performance limits of integrated optical spectrum analyzers have undergone a comprehensive analysis. Improvement in the Bragg cell bandwidth-efficiency product by up to an order of magnitude should be possible through the use of acoustic beam-steering or birefringent-diffraction techniques.

A superconductive convolver has been fabricated and tested in which a niobium-on-sapphire microstrip meander line provides electromagnetic delay for counter-propagating signal and reference waves. Capacitive taps along the delay path feed superconductive lead-niobium tunnel-junction mixers, and the local signal-reference products are summed spatially to form the desired convolution. This technology should provide for programmable matched-filtering of waveforms of up to 10-GHz bandwidth and 100-ns duration.

A sliding-window spectrum analyzer consisting of twelve identical surface-acoustic-wave (SAW) chirp-Fourier transform circuits is under development to process twelve parallel-beam Doppler-shifted CW returns from

an airborne infrared laser radar. Although not all the required reflective-array compressors have been fabricated, tests with existing compressors have shown that every system requirement has been met or exceeded, including an 84-kHz frequency resolution with 10-MHz analyzer bandwidth, >50 dB dynamic range, and sidelobes >25 dB down.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ESD-TR-82-009	2. GOVT ACCESSION NO. AD-A118 869	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Advanced Electronic Technology		5. TYPE OF REPORT & PERIOD COVERED Quarterly Technical Summary 1 November 1981 – 31 January 1982
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Alan J. McLaughlin and Alan L. McWhorter		8. CONTRACT OR GRANT NUMBER(s) F19628-80-C-0002
9. PERFORMING ORGANIZATION NAME AND ADDRESS Lincoln Laboratory, M.I.T. P.O. Box 73 Lexington, MA 02173-0073		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Program Element No. 63250F Project No. 649L
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Systems Command, USAF Andrews AFB Washington, DC 20331		12. REPORT DATE 15 February 1982
		13. NUMBER OF PAGES 28
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)* Electronic Systems Division Hanscom AFB, MA 01731		15. SECURITY CLASS. *(of this report)* Unclassified
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

None

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

digital computers	solid state devices	quantum electronics
integrated circuitry	materials research	microelectronics
computer systems	laser research	analog device technology

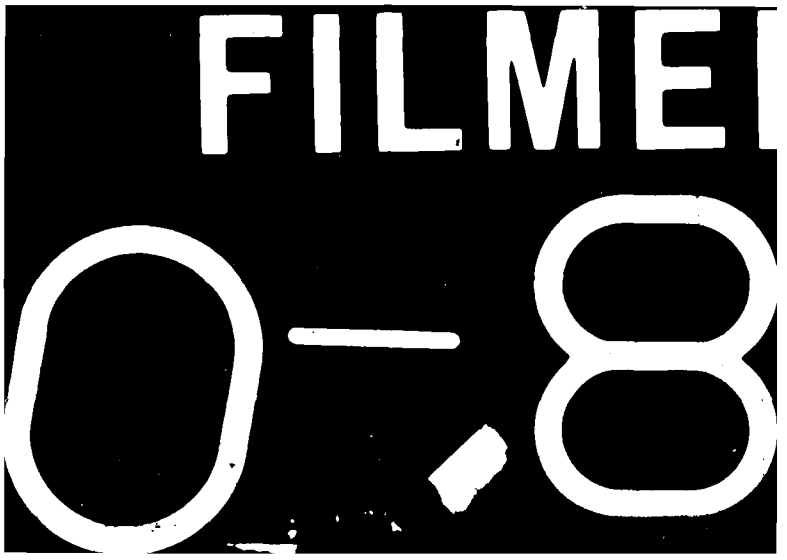
20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This Quarterly Technical Summary covers the period 1 November 1981 through 31 January 1982. It consolidates the reports of Division 2 (Data Systems) and Division 8 (Solid State) on the Advanced Electronic Technology Program.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*


FILME
0-8